Safety Tips for Avoiding Chemical Related Incidents

National Institutes of Health (NIH) • Office of Research Services (ORS) • Division of Safety (DS)

How to avoid chemical storage area fires/explosions and unwanted reactions?

Safe storage and management of hazardous chemicals is an essential part of laboratory safety. Hazardous chemicals that are stored in an inappropriate state, condition or place can cause fires, explosions and violent reactions. Below are some general situations that can lead to dangerous conditions in chemical storage areas:

1. **Degradation of the container/container failure**
    - Degradation of chemical containers over time can lead to releases which can cause violent reactions when the released chemicals encounter other incompatible substances that are present in the storage area. Degradation of the container may also cause water reactive/pyrophoric chemicals to self-ignite.
    - In some cases, deterioration of chemical containers can lead to rapid exothermic decomposition of the contents, which can fuel a fire or even lead to an explosion if mixed with combustible materials.

2. **Incompatible and improper storage:** Storing chemicals improperly, such as leaving containers open, improperly sealed or not segregated by hazard class, can increase the risk of explosions/fires and releases of hazardous vapors/gasses. For example, storing incompatible chemicals such as strong acids and bases or oxidizers and flammables together can lead to explosive reactions if they come into contact if spilled/leaked or vapors mixed from open or improperly sealed containers.
3. **Extended storage of peroxide forming chemicals:** Peroxide forming chemicals can form explosive levels of peroxides overtime if exposed to air, light or contaminated with other chemicals. These peroxides can explode violently when subjected to shock, friction or heat. Refer to NIH Fact Sheet for more information.
4. **Flammable liquids and vapors:** Flammable liquids from a damaged/improperly sealed container may release vapors in sufficient concentrations to cause fires/explosions when ignited on contact with electrical sparks/open flames. Ensure that flammables are stored in flammable storage cabinets and the storage does not exceed the approved capacity of the cabinet. Containers must be stored in an upright position with secondary containment to contain spills.

Recommendations for improving safety in chemical storage areas in the laboratory

1. Establish storage areas that are secure/locked, well-ventilated and away from high traffic, exits, and heat sources. Within the storage areas larger bottles should be in the back and smaller ones at the front for visibility. Use shelving with anti-roll lips to prevent bottles rolling/sliding off. Storage of chemicals on the floor, inside fume hoods, cold rooms, under the sink or on benchtops should not occur.
2. Regular inspections of the storage area by the laboratory staff can reduce the chances of fires/explosions and unwanted reactions. The inspection should cover the following items:
    - **Container integrity**
        - Inspect chemical containers for cracks, leaks and other damage including the label. Appearance of rust, caps that are cracked, build up around the cap/container, etc. are signs of degradation of the container. Replace the labels if faded/falling off. Never remove/deface the original label.
    - **Segregation and secondary containment**
        - Segregate chemicals based on hazard class and store separately from one another, either in separate storage cabinets or in appropriate secondary containment. Use safe storage locations like approved flammable/corrosives cabinets. Refer to storage cabinets , fact sheet on compatible storage, Chemical Segregation and Storage Table and NIH CHP for additional information.
        - Refrigerators/freezers used for storage of flammables must be appropriately rated and labeled.

- Label all containers including secondary containers (transfer container, spray bottles etc.). Label must be clear, legible, written in English, must contain the hazard class and appropriate pictogram (GHS labels available through the NIH Supply Center). Label PHS and peroxide formers by following NIH guidelines. Improper labeling and faded/fallen off labels can lead to mistakenly storing incompatibles together. Always return containers to their proper storage location after use.

- **Proper sealing and compatibility of the container**
  - Proper sealing of the container is vital for safety, preventing leaks and product integrity. Ensure the caps on containers are tightly secured and in good condition.
  - Ensure the storage container is compatible with the chemical stored inside, e.g., hydrofluoric acid should be stored in compatible containers other than glass as it can react with glass.

- **Condition of the chemical**
  - Assess the physical state of the chemical by visual inspection for signs of degradation, contamination and decomposition. Formation of crystals/turbidity, clumping, stratification and discoloration are indication of degradation or contamination. If you observe any of the above on chemical containers, **do not touch or move the container, contact the** Division of Safety **immediately**.

3. **Inventory management**
   - Maintain a chemical inventory, which should minimize the amount of chemicals ordered/stored in the laboratory. LabArchives, the electronic notebook used by many at NIH, has an inventory module. Follow the DS guidance document to learn how to use it.
   - Over-storage and crowding can cause breakages and spills. Regular review of the chemical inventory and disposal of unwanted/unused and expired chemicals can ensure appropriate chemicals are available for research and reduce incidents caused by over-storage/overcrowding.

Other situations that can lead to laboratory fires and incidents

1. **Uncontrolled reactions:** Exothermic reactions (reactions that release heat) if not controlled properly can cause fires. One example is quenching reactions involving pyrophoric/water reactive chemicals. Conducting risk assessments and developing/following standard operating procedures (SOPs) prior to the start of the procedures and working inside chemical fume hood with proper PPE can reduce the potential for incidents.
2. **Heat sources used in the laboratory:** Heat sources such as hot plates, mantles, heat guns, and Bunsen burners can be very dangerous if not managed properly. Never leave heat sources unattended and keep away from flammables. Use the appropriate heat source and heat setting for your experiment based on the physical properties of the reagents used and ensure the temperature controls are working properly. Equipment capable of igniting flammable vapors (heat guns, Bunsen burners etc.) should not be used to heat highly volatile solvents. Keep materials not involved in the experiment away. Turn off the heat source completely once the experiment is over.
3. **Improper management of chemical waste:** Improper management of chemical waste can have serious health, safety and environmental consequences. Segregate waste according to hazard class and manage/dispose appropriately by following NIH Waste Disposal Guide.

Spill and Emergency

The PI/supervisor is responsible for providing training for lab personnel in emergency response plans and location/use of emergency equipment. Follow NIH Spill and Emergency procedures and report all injuries to OMS. For additional resources refer to NIH Division of Safety (DS) Chemical Safety.